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THE USE OF THE ADSORPTION METHOD IN ACTIVATED CHARCOAL WITH EXTRACTION BY CHLOROFORM (CCE) TO EVALUATE THE CONTAMINATION OF RESERVOIRS BY ORGANIC MATERIALS

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THE USE OF THE ADSORPTION METHOD IN ACTIVATED CHARCOAL WITH EXTRACTION BY CHLOROFORM (CCE) TO EVALUATE THE CONTAMINATION OF RESERVOIRS BY ORGANIC MATERIALS

(Primeneniye metoda adsorbtsii na aktivirovannom ugle s ekstraktsiey khloroformom (CCE) dlya otsenki zagryazneniya vodoyemov organicheskimi veshchestvami)

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THE USE OF THE ADSORPTION METHOD IN ACTIVATED CHARCOAL WITH EXTRACTION BY CHLOROFORM (CCE) TO EVALUATE THE CONTAMINATION OF RESERVOIRS BY ORGANIC MATERIALS

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The attention of many researchers has been attracted to the method of adsorbing small amounts of organic contaminants in activated charcoal with their subsequent extraction with chloroform (CCE). In Soviet practice this method, recommended by international drinking water standards, has not yet been used. In recent years a number of works have been published dealing with the adsorption method of analyzing natural and purified water (Yu. Yu. Lur'ye and A. I. Rybnikova; O. N. Shemyakina, and others). It must be noted that adsorption columns of arbitrary size, different solvents or mixtures of solvents for extraction, as well as different parameters and means of water passage (from top to bottom, with alkalization or acidification) used by the authors of these works for the study indicate deviation from recommended international standards for the method. Therefore, it is impossible to compare the results obtained by these authors with regard to different reservoirs or with the data of a number of foreign researchers. Taking this into consideration, in 1967-1970 we conducted experimental research using the charcoal-chloroform extract method (CCE) in the Kama and Votkinsk reservoirs.

In 1967 a carbon-adsorption facility and an extraction device were constructed in accordance with the dimensions recommended by international water quality standards. Because of the lack of detailed descriptions of the construction of units to provide an even supply of water for a prolonged time, 2 systems to supply water to the adsorption column were developed under field conditions; they significantly increase the possibility of using this method for the sanitary protection of reservoirs. Because of the lack of information in the literature on brands of charcoal-adsorbent, we experimentally ascertained the advisability of using BAU-M charcoal in 0.5-1 mm granulation to solve these problems.

After selection of the brand of charcoal and testing the method under laboratory conditions, in 1967-1970 field studies were conducted on the Kama River in 7 control ranges operated by the city of Perm as well as in Perm tap water. The studies verified the possibility of using the charcoal-chloroform extract method in sanitary practice for comparative evaluation of the levels of contamination in river water by organic components of industrial discharges. Nevertheless, we must note that international standards lack recommendations concerning detailed quantitative and qualitative testing of individual organic

materials in this complex. This is demanded by the principles and methodological basis of Soviet water law which, founded on hygienic standardization, requires not only the quantitative characteristics of the total content of contaminants, but also quantitative and qualitative evaluation of individual components in this complex.

The integral index (CCE) is quite tentative and does not distinguish from the entire complex of organic contaminants those which determine the intensity of contamination of the reservoir. Therefore, further analysis of charcoal-

Results of the division of extracts by CCE into fractions

Fraction	Sewage		Water of Kama Riv.		Tap water of city of Perm	
	mg	%	mg	%	mg	%
Acid	32.9	7.5	30.4	17.5	29.42	55.5
Neutral	43.9	10.0	34.9	20.2	14.94	28.1
Phenol	6.2	1.4	5.2	3.0	6.89	13.0
Amphoteric	19.3	4.4	13.4	7.7	0.76	1.4
Basic	337.8	76.7	89.3	51.6	1.05	2.0

chloroform extract was required in order to reveal the content of individual organic materials. For this we, together with the Novocherkassk Hydrochemical Institute, developed a program to study the quality of water in reservoirs by the CCE method. The program covered quantitative measurement of the contamination of reservoirs by the CCE method, separation of extracts into fractions, interpretation of fractions and the extraction of individual components.

In accordance with this program, along with quantitative measurements of CCE content in the water of the Kama River and tap water in the city of Perm, in 1969-1970 we and workers of the Novocherkassk Hydrochemical Institute performed an experiment to separate extracts into fractions, making it possible to distinguish 5 basic groups of organic compounds (neutral, amphoteric, basic, phenol and acid). It was ascertained that in natural and waste water, a large proportion is comprised of basic, neutral and acid fractions, and in purified tap water — acid, neutral and phenol (see table). In addition, infrared spectrometer studies ("IR-20") of undivided extracts of sewage, river and purified tap water showed that the spectra of these extracts differed significantly from each other. Thus, present in the undivided extract of industrial discharge are dibasic amines of an aromatic character. Absorption bands in the 3040, 1585, 1555, 1505, 762 and 700 cm^{-1} regions characterize stretching vibrations of the benzene ring; 762 and 700 cm^{-1} indicate that the benzene ring is replaced by NH_2 groups in positions 1 and 3 (meta-replaced

benzene ring); absorption bands at 2940 and 2879 cm^{-1} indicate stretching vibrations of CH-groups in CH_3; in the 1450 and 1400 cm^{-1} region — deformation vibrations of the benzene ring — they indicate the presence of aliphatic methyl groups. The undivided extract of tap water had a different character. Functional groups which are present here, in particular absorption bands in the 3750, 3435 and 3200 cm^{-1} region, indicate stretching vibrations of OH groups, in the region of 1460 and 1390 cm^{-1} -- deformation vibrations of the benzene ring, etc. — typical of materials of natural origin, including phenols.

As large volumes of water are necessary to obtain the extract, these results are sufficiently representative. A study of these extracts makes it possible not only to differentiate individual samples of water according to their degree of contamination by organic materials, but also to determine the quantitative composition of contaminants.

A study by the CCE method requires the full participation of highly-qualified chemists and the use of special equipment (spectrographs, chromatographs, etc.). At the same time,the possibility of conducting the studies in stages allows extensive use of this method for the sanitary protection of reservoirs.

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